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NEW SPECIES OF *POLYMERUS* (WESTWOOD) FROM THE UNITED STATES (HEMIPTERA, MIRIDAE)

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Polymerus shawi n. sp.

Runs in the couplet with *severini* in my key (Miridae of Illinois, 1941) but distinguished by black color on apical half of femora, base and apex of tibiae.

♂. Length 5.1 mm., width 2.34 mm. Head: width 1.12 mm., vertex .51 mm.; black, a small yellow glabrous spot each side of vertex bordering eye. Rostrum, length 1.08 mm., just reaching middle of mesosternum, yellowish, apical half blackish. Antennae: segment I, length .39 mm., black, not equal to width of vertex; II, 1.99 mm., black, thickness almost equal to segment I, clothed with short, thick, pubescence; III, .65 mm., slender, yellow; IV, yellow. Pronotum: length 1.51 mm., width at base 1.86 mm., black, narrow basal edge and ventral edge by coxa, pale. Clothed with silvery, sericeous pubescence, intermixed with simple, more erect pale hairs. Hemelytra with costal margins very slightly arcuated; black, embolium pale, its apex and the cuneus sanguineous; membrane dark fuscous, veins yellowish. Legs yellow to light orange, coxae shaded with fuscous on base and sides; femora black on apical one-third, the black color broken by an incomplete annulus of yellow which on hind pair does not cross dorsal surface; tibiae yellowish, base and apex blackish; tarsi yellow, apical segment and claws black. Venter and thorax black, ostiolar peritreme and ventral margin of epimeron, pale to yellow.

Holotype: ♂, July 6, 1930, Ossipee, New Hampshire (S. A. Shaw); author's collection. *Paratypes*: 3 ♂, taken with the type. Named in honor of the collector, Mr. S. A. Shaw, who favored the author with these specimens.

Polymerus costalis n. sp.

Allied to *rubrocuneatus* Kngt., but distinguished by a shorter rostrum and pallid color of the embolium; differs from *rubroornatus* Kngt. in the much shorter rostrum, less tumid frons, and black legs.

♀. Length 4.85 mm., width 2.5 mm. Head: width 1.08 mm., vertex .56 mm.; black, with an orange colored glabrous spot each side of vertex. Rostrum, length 1.08 mm., scarcely attaining posterior margins of front coxae, or falling a little short of middle of sternum, black. Antennae: segment I, length .47 mm., black; II, 1.81 mm., black, finely closely pubescent, slightly more slender basally; III, .69 mm., brownish black; IV, .69 mm., black. Pronotum: length 1.04 mm., width at base 1.86 mm.; narrow basal margin of disk and ventral margin bordering coxae, pallid. Clothed with thickly matted, silvery sericeous pubescence and intermixed with short, simple pale pubescence. General coloration black, cuneus sanguineous, costal edge pale to yellowish, base of radius somewhat pale; membrane black, veins reddish brown to blackish; scutellum with brownish spot on apex; posterior edge of ostiolar peritreme and ventral edge of epimera, pallid. Legs and venter uniformly black.

Holotype: ♀, July 14, 1936, Uniontown, Washington (B. F. Coon); author's collection.

Polymerus standishi n. sp.

Distinguished from allied species by small size and by length of rostrum which just attains posterior margin of mesosternum; black, lateral margins of hemelytra broadly sanguineous.

♀, Length 4.4 mm., width 2.1 mm. Head: width 1.04 mm., vertex .49 mm.; back, glabrous marks each side of vertex reddish to brown. Rostrum, length 1.12 mm., just attaining posterior margin of mesosternum, dark brown to black. Antennae: segment I, length .39 mm., black; II, 1.51 mm., black, distinctly more slender than first segment; III, broken. Pronotum: length .95 mm., width at base 1.69 mm.; black, narrow basal margin of notum and the sternum, reddish. Clothed with silvery, sericeous pubescence and intermixed with more erect, simple yellowish hairs on head and dorsal surface. General color black, cuneus, veins, embolium and outer half of corium, and spot on base of clavus, sanguineous. Legs black or reddish black, hind coxae red, basal half of tibiae and sometimes the femora more red than black.

Holotype: ♀, June 11, 1937, Lugert, Oklahoma (Standish-Kaiser); author's collection. *Paratype*: ♀, taken with the type. Named for the collector, Mr. John Standish.

***Polymerus sculleni* n. sp.**

Allied to *brevis* Kngt., but second antennal segment longer, exceeding width of head; scutellum white with basal angles black, pronotum with median white stripe.

♀. Length 5.1 mm., width 2.0 mm. Head: width 1.16 mm., vertex .56 mm.; black, basal carina and a triangular spot on vertex bordering eye, white, a pale spot on median line joining the carina, bucculae with narrow apex pale; frons rather full and prominent, tylus not visible from above. Rostrum, length 2.03 mm., reaching to base of fifth ventral segment, black, basal segment white, base fuscous. Antennae: segment I, length .41 mm., black; II, 1.38 mm., cylindrical, slightly more slender on basal half, black, more brownish on basal half, clothed with suberect, bristle-like pubescence; III, .69 mm., black; IV, .52 mm., black. Pronotum: length .86 mm., width at base 1.51 mm.; black, collar, sternum, ventral margins of propleura, and median line of disk, yellowish white. Scutellum white, basal angles and mesonotum black. Hemelytra black, cuneus, embolium and outer one-third of corium white, clavus pale to brownish on inner half. Membrane dark fuscous, veins scarcely paler. Clothed with recumbent, silvery sericeous pubescence and intermixed with more erect, pale simple pubescence, these hairs rather prominent on head as elsewhere. Venter largely white, lateral margins black, the dark color projecting into the white like saw-teeth, the ventral median line shaded with fuscous. Legs white, shaded and marked with fuscous and black; middle of coxae, base of femora and two more or less interrupted bands, and ventral surface of tibiae fuscous to black; tarsi black.

Holotype: ♀, July 26, 1930, Drake Peak, alt. 7,850 ft., Lake Co., Oregon (H. A. Scullen); author's collection. *Paratypes*: 3 ♀, taken with the type. Named in honor of the collector, Dr. H. A. Scullen, of Oregon State College.

***Polymerus hirtus* n. sp.**

Allied to *brevis* Kngt., but distinguished by the shorter rostrum, also by the longer second antennal segment; head and pronotum clothed with erect long hairs; tibiae reddish brown.

♂. Length 4.5 mm., width 1.84 mm. Head: width 1.05 mm., vertex .56 mm.; black, basal carina broad, pallid; frons prominent, strongly convex, thickly clothed with prominent setose hairs. Rostrum, length 1.82 mm., reaching slightly behind posterior coxae or upon third ventral segment, black, basal segment largely pallid. Antennae: segment I, length .35 mm., black; II, 1.21 mm., black, cylindrical, slightly more slender near base, clothed with fine pubescence and intermixed with a few erect setose hairs; III, .56 mm., black; IV, broken. Pronotum: length .86 mm., width at base 1.51 mm.; black, ventral edge of propleura pale; clothed with silvery sericeous, appressed pubescence, and intermixed with erect setose hairs which are more abundant anteriorly and on lateral margins. Scutellum black, transversely rugulose, mesonotum black.

Hemelytra with lateral margins nearly parallel; black, cuneus, embolium and edge of corium yellowish to white, membrane and veins fuscous; clothed like the pronotum, the erect setose hairs on the pale areas appear blackish. Venter and thorax black, ventral edge of metapleura pale, clothed with silvery sericeous pubescence, the genital segment with erect long hairs. Legs black, tibiae and apices of femora reddish brown, tarsi and tips of tibiae blackish.

Holotype: ♂, July 12, 1928, Henry's Lake, Idaho (C. Wakeland); author's collection.

***Polymerus fasciolus* n. sp.**

Allied to *elegans* Reut., but size smaller, rostrum and antennal segments shorter, apical half of femora banded with blackish.

♂. Length 2.8 mm., width 1.4 mm. Head: width .82 mm., vertex .35 mm.; a rather large spot each side of vertex bordering eye and extending below upon base of frons, base of juga, lorae, and anterior half of bucculae, pale yellowish. Rostrum, length 1.10 mm., reaching to middle of hind coxae, yellowish to brown, apex black. Antennae: segment I, length .35 mm., dark brown to fuscous, more yellowish on dorsal surface; II, 1.43 mm., yellowish brown, blackish near base and brownish black on apical one-fourth, thickness about equal to segment I but slightly more slender on basal half; III, .65 mm., brownish black; IV, missing. Pronotum: length .69 mm., width at base 1.17 mm., black, basal margin, ventral margin to height of coxal cleft, sternum, and collar except behind eyes, pale to yellowish. Scutellum black, a diamond-shaped spot on apical half including all of apex, pale yellowish. Hemelytra black, basal half of corium and extending slightly further along radius, apex of clavus, embolium except black mark near apex, edge of corium bordering cuneus and small spot on inner apical angle, pale yellowish to white; cuneus with base and apex white, discal area reddish brown, outer edge except apex black; membrane dark fuscous, veins white. Ventral surface black and white, costular peritreme, posterior edge of epimera, and broad stripe on sides of venter but interrupted on base of genital segment, white. Coxae black, a pale spot near base; femora yellowish white, narrow band at base, a broad band beginning at middle and a narrow subapical ring, blackish, apices more yellowish orange; tibiae pale, apex and subbasal band blackish, the latter interrupted on dorsal surface; tarsi blackish.

Holotype: ♂, August 3, 1929, Payson, Arizona (E. D. Ball); author's collection.

***Polymerus vittatipennis* n. sp.**

Allied to *sericeus* Uhler in having the rostrum barely attaining posterior margins of hind coxae; differs in having femora devoid of annuli, but sometimes with fuscous dots on anterior aspect; corium with distinct wedge-shaped fuscous mark.

♂. Length 3.9 mm., width 1.8 mm. Head: width .95 mm., vertex .43 mm.; pale to orange, tylus except margins, and frons except median line, black; eyes brownish black. Rostrum, length 1.64 mm., reaching to near apex of hind coxae, pale, apical segment black. Antennae: segment I, length .41 mm., black; II, 1.9 mm., cylindrical, slightly more slender near base, yellowish brown, blackish at base; III, .86 mm., brown to fuscous; IV, .48 mm., fuscous. Pronotum: length .86 mm., width at base 1.56 mm.; pale yellowish to brownish and marked with black; inner and outer angles of calli with broad black spots which in darkest specimens extend back upon disk as black rays. Scutellum pale to yellowish, base and basal angles more or less black. Clothed with pale sericeous, recumbent pubescence, and intermixed with pale and fuscous simple hairs. Hemelytra with costal margins nearly straight, pale to yellowish brown, corium with fuscous to black wedge-shaped mark, the outer edge bordered by radial vein while the base of wedge extends to inner angle of cuneus; clavus blackish

on inner half, claval vein more pallid than outer half of clavus. Cuneus pallid, disk usually orange colored. Membrane uniformly fuscous, veins pale. Sternum fuscous, pleura except margins fuscous. Legs yellowish to orange colored, femora without annuli, but dark specimens may have three or four fuscous points apically on anterior aspect; tibiae pale, spines black, tarsi brownish, apical segment and claws black. Venter pale, a line of impressed dark spots along each side which in dark specimens may become a heavy black line; genital segment brown to blackish beneath.

♀. Length 4.3 mm., width 2.2 mm. Head: width 1.06 mm., vertex .49 mm. Pronotum: length 1.08 mm., width at base 1.9 mm. Antennae: segment I, length .39 mm.; II, 1.8 mm.; III, 1.0 mm.; IV, .60 mm. More robust than the male but very similar in coloration, although females generally with the black marks much reduced in size and intensity.

Holotype: ♂, September 29, 1940, Geronimo, Arizona (Lloyd L. Stitt); author's collection. *Allotype*: same data as the type. *Paratypes*: ARIZONA—Geronimo: 5 ♂, 3 ♀, taken with the types on *Gutierrezia* (Lloyd L. Stitt). NEW MEXICO—Jemez Springs: ♀, September 15, 1919, alt. 6400 ft. (J. Woodgate). Los Lunas: 6 ♂, 1 ♀, September 8, 1931 (H. H. Knight). State College: 1 ♀, August 27, 1941. UTAH—Leeds: 4 ♂, 2 ♀, October 12, 1932 (E. W. Davis).

TWO NEW SUBSPECIES OF *INCISALIA* (LEPIDOPTERA, LYCAENIDAE)

BY HARRY K. CLENCH,

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Through the kindness of Mr. Don B. Stallings, of Caldwell, Kansas, the author received for examination a small series of an *Incisalia* that appears to represent a race of the eastern *I. henrici* Grote and Robinson.* This series was later augmented by about 40 more specimens from Mr. Stallings and 32 from an adjacent locality taken and sent by Mr. Robert Whittaker, of Eureka, Kansas. With this series it was possible to draw up a good description of the subspecies and to obtain quite accurate ideas as to the extent of its variation. In addition to this material, both Mr. Stallings and Mr. Whittaker sent further specimens for comparison, for which many thanks are due.

Concerning the habits of this race, which appears to be more abundant than the typical eastern one, Mr. Stallings writes in a recent letter to the author, "It may be of value to you to know that we collect these *henrici* along the Arkansas River, which winds back and forth across the boundary of Sumner and Cowley Counties. We catch them feeding on the bloom of the redbud trees which grow on the sand hills along the banks of the river. Farther east (10 to 25 miles) the redbud grows in the flint hills, and here again we take *henrici* [*turneri*] in the canyons, or ravines, as they are often called."

W. D. Field has recorded the occurrence of this subspecies under the typical name in his "Manual of the Butterflies and Skippers of Kansas" (Bull. Univ. Kansas 39, p. 152, May, 1938).

Incisalia henrici turneri n. subsp.

UPPERSIDE:

Male. Uniform dark brown. *Fore wing* frequently (roughly 60%) with a brassy fulvous scaling between the veins. *Hind wing* with a short, broad, poorly defined, marginal-fulvous band from the anal angle to vein M_3 , M_2 , or

**Thecla henrici* Grote and Robinson, 1867, Trans. Am. Ent. Soc., I, pp. 174-176 (Descriptions of American Lepidoptera No. 2.).

even occasionally almost to costa. This band is composed of joined lunules and, as a consequence, is basally scalloped. Infrequently this is limited to merely a heavy lunule, not going beyond Cu_1 . The veins are frequently black through this band.

Female. Similar to the male, but with the fulvous brighter, more ruddy, and extended to cover nearly the whole of the fore wing except the basal third, and a strip on the costa and outer margin. This strip varies on the latter from less than 0.5 mm. to slightly over 1 mm. in width. On the hind wing the basal half, costa and inner margin are dark brown, the remaining bright fulvous as on the fore wing. The outer marginal strip is on this wing so thin as to be almost non-existent.

Fringe, both sexes: on the fore wing black, broadly checked with white between the veins; on the hind wing similar near the outer angle, but towards the anal angle (beyond M_3) it is white basally and black outwardly, produced at the vein-ends (uniformly black), producing a scalloped effect. At Cu_2 the fringe is produced to form an actual tail.

UNDERSIDE:

Male. Fore wing: inner marginal area from vein Cu_2 gray, dark towards the base, lighter outwardly. Cell closed by a dark bar. A post-discal, dark, gray-brown line of varying intensity starts at the costa and proceeds to vein Cu_2 , where it ends abruptly. Very rarely this line is continued into the next interspace, where it angles sharply inward, and then outward. This line is outwardly bordered with white, thickest at the costa, and gradually diminishing towards the line's terminus. Basal to this line the ground color is grayish fulvous, becoming almost black-brown at the base. Outward of the line the color is light tan, occasionally scaled with fulvous. Near the costa, adjoining the post-discal line, this tan is frequently so pale as to appear almost white. There is a submarginal row of spots paralleling the outer margin, but it is almost invariably obsolete save for one each in the $M_2-M_3-Cu_1-Cu_2$ interspaces, and usually all but those in the last two are absent. Occasionally they are all wanting. There is a faint and very obscure border of brownish fulvous just outward of this row of spots. *Hind wing* with the basal half black-brown, overlain with scattered pale scales and frequently with a ruddy patch on the costa. Outer border of this black area commences two-thirds out on costa, proceeds straight to M_1 , basally dislocated from M_1 to M_3 , outwardly dislocated from there to Cu_2 , and from Cu_2 to the inner margin again basally dislocated and also sinuate, striking the inner margin at about the midpoint. This border is heavily margined outwardly with white on the costa and on the inner margin; less so (frequently scarcely at all) on the remainder. Beyond this border is a row of more or less obsolescent dots, which, when present, usually take the shape of a flattened V, its apex inward. Between the border of the dark basal area and this row of dots is a strip of tan, occasionally rather pale. Outward of the dots, from anal angle frequently almost to costa, is a broad band of hoary grey, replaced costad by brown. Not infrequently this gray shades over near the inner margin into the tan strip immediately basal. In the hoary area, just marginal to the spots in the cubital interspaces, sometimes even marginal to all the spots, is a row of pale, almost circular dots of an obscure tan color, one to each spot. Occasionally the dot in the Cu_1-Cu_2 interspace is minutely pupilled with black on its outer edge. This is a relic of the anal spot, characteristic of most Theclinae and of a large number of other Lycaenidae.

Female. Similar to the male. On the fore wing the post-discal line is more frequently, but similarly, extended into the next (Cu_2-2A) interspace. In several females it was observed in a more or less advanced state (nearly as well developed as the remainder of the line), but in the males it was at most rather

feebly represented. This extension of the post-discal line is accompanied by an encroachment of the ground color on the gray inner marginal area.

Length of fore wing. Male: large, 13 mm.; average, 11.83; small, 10. Female: large 13; average, 11.93; small, 11. Measurements based on entire type series up to no. 83, individual measurements accurate to one-half millimeter.

Holotype, male, Cowley County, Kansas,* April 12, 1942.

Allotype, female, same data.

Paratypes, no. 1 to 15 (12 males, 3 females), same locality, April 20, 1941; no. 16 to 42 (13 males, 14 females), same data as holotype; no. 43 to 52 (7 males, 3 females), same locality, April 17, 1942; no. 53 to 61 (8 males, 1 female), Eureka, Kansas, April 4, 1942 (R. Whittaker); no. 62 to 69 (3 males, 5 females), Eureka, Kansas, April 12, 1941 (R. Whittaker); no. 70 to 83 (13 males, 1 female), Eureka, Kansas, April 13, 1941 (R. Whittaker); no. 84 to 87 (3 males, 1 female),† Cowley Co., Kansas, April 20, 1941; no. 88, male, Eureka, Kansas, April 20, 1941 (R. Whittaker).

Holotype, *allotype*, and *paratype* no. 76, no. 26011 in the Museum of Comparative Zoölogy. *Paratypes* no. 4, 14, 16-19, 28, 30, 31, 35, 36, 39, 48, 53-55, 58, 61, 64, 66, 67, 73 and 74 in the author's collection. *Paratypes* no. 1-3, 5-13, 15, 20-27, 29, 32-34, 37, 38, 40-47, 49-52, 57, 62, 63, 65, 68-71, 75 and 77 in the collection of Mr. Stallings. *Paratypes* no. 56, 59, 60, 72 and 78-83 in the collection of Mr. Whittaker. *Paratypes* no. 84-87 in the collection of Mr. C. F. dos Passos, Mendham, New Jersey. *Paratype* no. 88 in the collection of Mr. I. P. Gray, Lincoln, Maine.

Remarks. This western race differs from the typical (eastern) one in several respects. In size, *turneri* averages slightly larger than *henrici*. Below, especially in the males, *turneri* is paler and nearly always appears more washed-out than in the typical race. The marginal area on the fore wing below is considerably lighter than the rest of the wing, especially near the costa and immediately outward of the post-discal line. The hoary marginal area on the hind wing below averages slightly larger. The lighter costal patch in the dark basal area is on the whole clearer and more definite. The marginal border of this dark area is a little more heavily edged with white. Above, the fulvous markings of both sexes are on the whole heavier, males of *turneri* frequently showing considerable fulvous on the fore wing, which very rarely occurs in the typical subspecies.

Variation is quite apparent in *turneri*, but not excessive. Several of the *paratypes* show a greenish shading below to which the term viridescence would apply. A number of *paratypes* (principally from Eureka) exhibit a tendency towards the typical subspecies in the darkness of the marginal area of the fore wing below, but a grayish cast to this wing differentiates them from true *henrici*. There is noticeable variation in the post-discal line on the fore wing below, which in *turneri* is usually quite heavy and dark, but varies from that to almost non-existence. In true *henrici* this line is seldom if ever heavy. Other minor variations, some mentioned in the description, also occur.

Comparisons have been made with specimens of the typical subspecies from various localities in eastern Massachusetts, and from Albany, New York. A number of specimens from Topeka, Kansas, have also been examined and are perfectly good *turneri*.

This subspecies is named for Dr. J. R. Turner, of Caldwell, Kansas, who collected part of the type series.

A second new subspecies, of very great interest, was recently sent the

*All specimens from Cowley County were collected jointly by: Mr. and Mrs. D. B. Stallings, Dr. and Mrs. R. C. Turner, Dr. J. R. Turner, Mr. and Mrs. H. E. Jenista.

†The *paratypes* numbered beyond 84 (inclusive) were examined after the numbering of the others was completed, and so could not be placed in their proper place.

writer by Mr. Robert G. Wind, of Berkeley, California. The specimens were taken by him while on a collecting trip to the Californian Sierras, and appear to represent a very distinct subspecies of the recently described *I. doudoroffi*.*

***Incisalia doudoroffi windi* n. subsp.**

UPPERSIDE:

Female. Both wings yellowish fulvous. *Fore wing* with outer margin gray-brown, thicker at the apex. Base gray-brown, gradually merging with the ground color. *Hind wing* with costa and inner margin pale gray. Base gray-brown, more broadly so than on fore wing. *Fringe* of fore wing gray, of hind wing gray outwardly, paler inwardly.

UNDERSIDE:

Female. Fore wing fulvous, gray-brown basad. Inner margin to Cu_2 gray. A post-discal line, black and rather obscure, crosses the wing from costa to Cu_2 . Between the line and the outer margin is an obsolescent row of spots, one to each interspace, from apex to Cu_2 . On the outer margin the fulvous is more intense and extends down below Cu_2 into the Cu_2-2A interspace. *Hind wing* with a basal area of gray-fulvous, slightly darker at the base. This area is limited outwardly by a tortuous, narrow line of black, basally edged with fulvous. This line is outwardly displaced in R_5-M_1 , and M_3-Cu_2 ; in the last greatly so. Between this line and the outer margin is a row of internervular spots, occasionally obsolete between M_2 and the anal angle. From M_2 to inner margin, between these spots and the border of the basal area, is a grayish region. Outward of these spots is a marginal band of orange fulvous, paler basad (just outward of the spots). *Fringe* as on upperside.

Length of fore wing. Female: 11.5-13.5 mm.

Holotype, female, Placer County, California, May (ex coll. E. I. Huntington).

Paratypes, one female, Gold Lake, Plumas County, California, July 10, 1941 (R. G. Wind); one female, Mt. Elwell, California, July 14, 1941 (R. G. Wind); one female, "Sier. Nev. Cal." (ex coll. Hy. Edwards).

Holotype and last paratype in the collection of the American Museum of Natural History. One paratype in the collection of Mr. Wind, and one in that of the author.

Remarks. This is a sierran race of *doudoroffi*, and apparently transitional from that species to *I. fotis*†. From *doudoroffi* it may be told (in the female) by the paler and more extended fulvous above and the more yellowish color below (applying especially to the basal area on the secondaries). Certain more brightly colored *fotis* approach this form, but may be told instantly, not only by the distinctly grayer under surface, but (again in the female) by the much reduced fulvous above.

Incisalia doudoroffi is undoubtedly a very good species, differing greatly from *moisii*‡, especially below, but in characters not casually seen, thus giving a closer superficial similarity between the two than actually exists, although both are obviously in the same branch of the genus. It is evidently fairly closely allied to *I. fotis*, which has heretofore held a rather indefinite position in so far as its relationships with other species are concerned.

Comparisons have been made with two topotypical *doudoroffi*, kindly lent by Mr. Wind, and several *fotis*, from Eureka, Utah, and Fort Wingate, New Mexico.

**Incisalia doudoroffi* dos Passos, 1940, Can. Ent. 72, p. 168 (A New Species of *Incisalia* from Southern California).

†*Thecla fotis* Strecker, 1877, Lepid. Rhop. and Het., Indig. and Exot., etc. p. 129.

‡*Thecla irus* var. *moisii* Hy. Edwards, 1881, Papilio 1, p. 54 (On Some Apparently New Forms of Diurnal Lepidoptera).

NEW DESCRIPTIONS OF LARVAE OF FOREST INSECTS, VII, *PERO*,
NEPYTIA, *CARIPETA* (LEPIDOPTERA, GEOMETRIDAE) *

BY W. C. MCGUFFIN,
 Ottawa, Ontario

***Pero morrisonarius* Hy. Edw.**

(Pl. XV, fig. a)

Antepenultimate Instar: Width of head 1.4 to 1.5 mm. Body 10 to 11 mm. in length and 1.5 to 1.9 mm. in width. Epicranial index 1.2 to 1.3. Ocelli 1 and 2 often contiguous but occasionally slightly separated. Crochets on ventral proleg number about 40.

Penultimate Instar: Width of head 1.9 mm. Body 12 mm. in length and 1.5 mm. in width. Epicranial index 0.8. Ocelli 1 and 2 contiguous. Crochets on the ventral proleg number 35.

Ultimate Instar: Width of head 2.2 to 2.5 mm. Body 25 to 40 mm. in length and 2.3 to 3.8 mm. in width. Body widest at 8th abdominal segment from which it tapers evenly anteriorly and posteriorly. Integument densely covered with minute convex granules. Ground color of body dirty white with gray or light brown marbling. The presence or absence of the dorsal lines varies from one individual to another; whenever and wherever present, they appear as gray lines. Supraspiracular line gray, geminate. Spiracular line gray, often ridged. Midventral line white, strongest on 1st abdominal segment where it is flanked by black or brown lines; present also on 2nd abdominal and represented on the next three abdominal segments by white markings. Head covered with minute convex granules; apices of vertex pointed; face concave. That dorsal portion of the vertex in the same plane as the dorsum of the prothorax is light brown; rest of head light brown or cream, dotted and marked with brown; ocellar area light. Adfrontals light brown to brown; quite narrow between the adfrontal setae, sutures light and sinuate. Frons light brown with brown band joining adfrontal setae 2; dark spot at each corner of base; apex attenuate. Postclypeus granulose, light brown with a brown patch on the median line. Preclypeus translucent dirty white. Labrum light brown, deeply cleft at an angle of 75 degrees. Prothoracic shield ground colour with middorsal line crossing it. Anal shield truncate at posterior end, of ground colour with brown lateral edges and gray or brown markings along median line; many brown pits scattered over the surface. On the thorax, the setigerous tubercles are composed of dark brown papillae or rings set directly on the integument; on the abdomen, the papillae are set either on small convex pinacula or on brown chalazae, viz., setae lambda, sigma and tau; areas around the tubercles dusky in colour. Setae long, brown, conspicuous. Spiracles oblong-elliptical in shape, with thin brown rims and light brown centres. Thoracic legs gray or brown. Prolegs gray with brown markings; ventral bear 46 to 50 crochets; anal bear poorly developed lateral plates and a dark stripe along the front of the leg.

Mouthparts: Mandibles (fig. a) brown with three ridges and the lower area of the chewing surface sculptured. There are nine teeth, the first tooth being so much reduced that it appears only as a slight bulge. The third, fourth and fifth teeth are crenulate. Hypopharynx (Part V, fig. d) of the usual type. Spinneret cylindrical, rounded at apex. Labial palpi with segments in the ratio of 18, 5 and 8.

Food Plants: White spruce, tamarack, balsam and white pine.

***Nepytia canosaria* Wlk†**

(Pl. XV, fig. b)

Green Phase

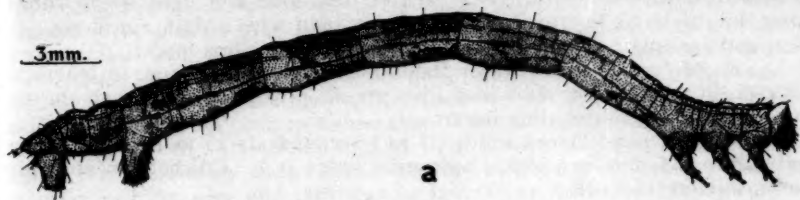
First Instar: Head width 0.3 mm. Body 5.0 mm. in length and 0.3 mm. in width. Body light gray with light subdorsal, spiracular and midventral

*Contribution No. 2178 from the Division of Entomology, Science Service, Department of Agriculture, Ottawa.

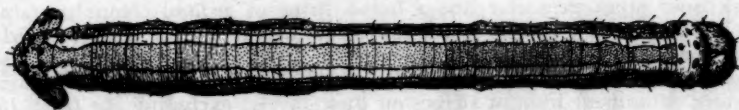
†Described also by A. S. Packard (1890), Fifth Report of the Entomological Commission, p. 781.



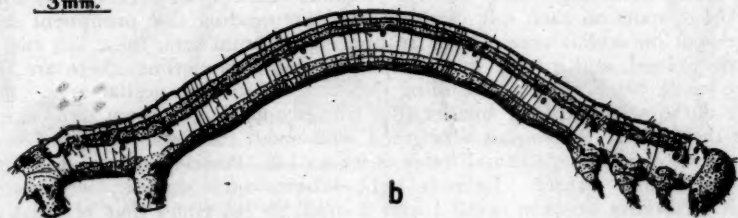
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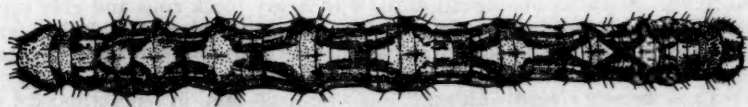
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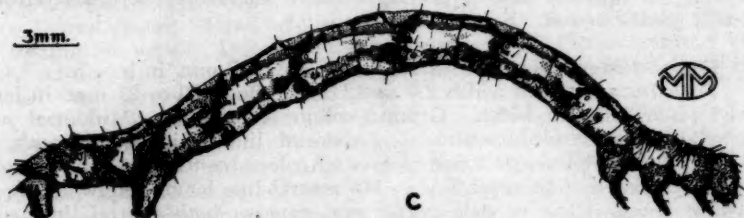
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b



3mm.



c

LARVAE OF FOREST INSECTS

- a, larva of *Pero morrisonarius* Hy. Edw. (ultimate instar).
 b, larva of *Nephya canosaria* Wlk. (sixth instar).
 c, larva of *Caripeta divisata* Wlk. (sixth instar).

lines. Head, prothoracic shield, anal shield, lateral plates on the prolegs, setigerous tubercles and prothoracic legs, black.

These larvae feed on the opening buds of spruce and balsam.

Second Instar: Head width 0.6 mm. Body 7.0 mm. in length and 0.6 mm. in width. Body light gray with all the lines of the later stages present. Head gray with dark gray spots. Over each vertical lobe is a light streak running from the subdorsal line to the frons. Frons light with a dark apical tip. Cervical and anal plate light gray with gray spots; thoracic legs black.

Third Instar: Head width about 1.0 mm. Body 10 mm. in length and 1.0 mm. in width. The spots and lines are all prominent and much the same in colour as in the succeeding instars.

Fourth Instar: Head width 1.3 to 1.5 mm. Body 15 to 18 mm. in length and 1.2 to 1.4 mm. in width. Epicranial index is 1. Crochets on abdominal proleg number 14 to 18.

Fifth Instar: Head width 1.9 to 2.1 mm. Body 12 to 25 mm. in length and 1.5 to 1.9 in width. Subcylindrical in shape. Skin densely covered with minute conical granules. Ground colour green; middorsal line a broad, green stripe; subdorsal line lemon-yellow edged on either side with a fine greenish black line; supra-spiracular line a broad stripe of ground colour containing a pair of faint, wavy, broken black lines. Spiracular line is yellow, edged with fine, black lines; subspiracular line green. Midventral line a broad, yellow stripe with much green suffusion, also edged with fine black lines. There are fourteen prominent lines or stripes on these larvae, excluding the faint, broken lines in the supraspiracular area. The head, covered with minute ridges, is blue-green with large, more or less circular, black spots arranged as follows: five large spots on each side of the vertex surrounding five prominent setae, a large spot on ocellar area, a spot around each frontal seta, these last two spots usually joined, and a faint spot at apex of frons. Sometimes there are two or three small, black spots surrounding the setae behind the ocellar area. Besides these dark spots there are smaller, less conspicuous light brown spots scattered over the vertex. Adfrontals blue-green with small dark spot at seta 1, sutures slightly wavy. The epicranial index is 0.8 to 1.0. Postclypeus brownish green; preclypeus dirty white. Labrum light brown, with shallow, well rounded notch. Distance between ocelli 1 and 2 equal to $1\frac{1}{2}$ times that between ocelli 2 and 3. Prothoracic shield green with four black spots on each side, one around each seta. Anal shield green with large black spots around each seta and small brown pits scattered over it; truncate at posterior end. Setigerous tubercles composed of small flat papillae set directly in the integument. Setae fine, inconspicuous. Spiracles oblong-elliptical, with heavy black rims and gray centres. Coxae of thoracic legs green, claws brown and remainder of legs light green. Prolegs green with small black spots around setigerous tubercles, each ventral proleg bearing 13 to 28 crochets.

Sixth Instar: Head width 2.4 mm. Body 20 mm. in length and 2.4 mm. in width. In this, the last or prepupal instar, the larvae becomes yellowish, especially on the venter. Epicranial index is 0.9.

Ferruginous Phase

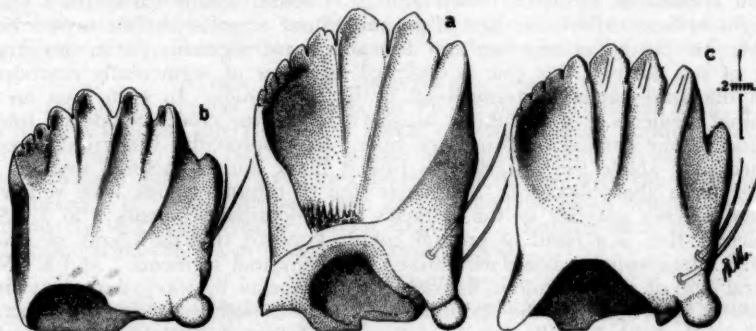
Fourth Instar: Head width 1.5 mm. Body 1.2 mm. in length.

Fifth Instar: Head width 2.0 to 2.1 mm. Body 20 to 25 mm. in length and 1.7 to 2.5 mm. in width. Ground colour ferruginous. Middorsal stripe light yellow with reddish suffusion. Subdorsal line white, edged with fine black lines. Supraspiracular stripe of ground colour, containing a fine, broken, light line flanked by fine, black lines. Midventral line lemon-yellow and broad; subventral lemon-yellow or pale purple and narrow; both ventral lines edged with fine black lines. Head ferruginous, with black spots arranged as in the green phase. The small black spots posterior to the ocellar area are always present and prominent. The smaller, less conspicuous light brown spots of the green phase are often very dark brown and conspicuous in this phase.

Adfrontals light with dark spots about setae; sutures slightly wavy. Frons light or dirty white with two black bars, one just below apex and one at base. Epicranial index 0.8 to 0.9; distance from ocellus 1 to 2 approximately $1\frac{1}{2}$ times that from 2 to 3. Postclypeus brown; preclypeus dirty white. Prothoracic and anal shields ground colour with black spots around the setigerous tubercles. Setigerous tubercles consist of small flat papillae set directly on the integument. Spiracles gray with heavy black rims. Thoracic legs and prolegs ground colour with black spots. Each abdominal proleg bears about 19 crochets.

Sixth Instar: Head width 2.5 mm. Body 20 mm. in length and 2.8 mm. in width. Epicranial index 0.7. Each ventral proleg bears 25 crochets. In other respects, this larva resembles that of the preceding instar.

Mouthparts: Mandibles (fig. b) light brown, with two main ridges and two or three secondary ones. The teeth vary in number and shape; there may be either eight or nine and they may be pointed or truncate. Hypopharynx of the usual type. Spinneret short and truncate and labial palpi with segments in the proportion of 8, 3 and 9.



a, mandible of *Pero morrisonarius* Hy. Edw.

b, mandible of *Nepytia canosaria* Wlk.

c, mandible of *Caripeta divisata* Wlk.

Food Plants: White, black, red and Engelmann spruce; hemlock, balsam, tamarack, white cedar, Douglas fir, white, red and jack pine; white birch.

Caripeta divisata Wlk.

(Pl. XV, fig. c)

Egg: Length 0.6 to 0.8 mm. Width 0.5 mm. Oblong in shape, pearly white in colour with smooth surface. Laid singly or in small groups on the needles.

First Instar: Head width 0.43 to 0.45 mm. Body 4 to 6 mm. in length. Body green with a light brown stripe on each side; head brown.

Second Instar: Head width 0.65 to 0.70 mm. Body 10 mm. in length and 0.8 mm. in width. Dorsum light brown or green. Pleura yellow. Venter ruddy yellow, with weak grayish brown midventral line. Head light ruddy brown. No tubercles present.

Third Instar: Head width 0.8 to 1.1 mm. Body 10 to 18 mm. in length and 0.8 to 1.0 mm. in width. Dorsum gray with fine, wavy brown lines; yellow on sides; venter tan with faint, fine, brown lines. Head light brown with faint herringbone patterns along epicranial stem. Epicranial index 0.9. Setigerous tubercles present, small, brown, convex.

Fourth Instar: Head width 1.2 to 1.5 mm. Body length 10 to 20 mm. Body width 1.0 to 1.5 mm. Ground colour of body is grayish brown. Dorsum of ground colour with fine, wavy brown lines and light patches between setae alpha and beta. Dark brown or black obliques run down and backwards behind

the abdominal spiracles. Anterior to each spiracle is a light yellow patch. Venter gray brown with fine brown lines. Head is light brown with brown herringbone markings along epicranial suture and on sides of head; a light patch on each vertical lobe. Frons yellowish with brown marking medially. Epicranial index 0.8 to 0.9. Distance between ocelli 1 and 2 equal to one and a quarter times that between ocelli 2 and 3. Setigerous tubercles conspicuous, the posterior ones being usually longer than the anterior ones on the same segment. Setae moderately long, brown.

Fifth Instar: Head width 1.5 to 1.8 mm. Body length 15 to 21 mm. Body width 1.5 to 2.2 mm. Epicranial index 0.7 to 0.8. Distance from ocellus 1 to ocellus 2 equal $1\frac{1}{2}$ to 2 times that from ocellus 2 to ocellus 3. Crochets on abdominal proleg number 30.

Sixth Instar: Head width 1.9 to 2.4 mm. Body length 30 to 35 mm. Body width 2.5 to 3.0 mm. Integument smooth. Body tapering gradually anteriorly and posteriorly from the 6th abdominal segment, bearing a tuberculate ridge on abdominal segment 8 between beta setae; these ridges may be faintly replicated on abdominal segments 1 to 7 and 9. Ground colour varies from yellow to light brown. Middorsal line of ground colour edged with fine brown lines; visible on prothorax and 8th and 9th abdominal segments. On the greater part of the dorsum, this line is observed as a row of segmentally reproduced light diamond-shaped areas outlined by dark obliques. In each area on abdominal segments 1 to 4, there is usually a small gray cross. Subdorsal line of ground colour flanked by thin dark lines. Supraspiracular line ruddy brown; immediately above the spiracle this line is black and is inclined towards the venter for a short distance. Spiracular line of ground colour with yellow or orange patches anterior to the spiracles on abdominal segments 1 to 5. Subspiracular line is a band of ground colour between fine dark gray or brown lines; it often appears as a dark oblique on abdominal segments 7 and 8. Mid-ventral line of ground colour flanked discontinuously by wavy, dark gray lines. A pair of dark spots on the abdominal segments denote the setigerous tubercles bearing sigma setae. Subventral line more or less broken, light brown, flanked by thin dark lines. Head smooth, light brown with dark brown herringbone patterns along epicranial suture, and with dark markings between apex of vertex and ocellar area; these markings may enclose light areas. A light stripe runs from back of head, over apex of vertex to include vertical setae 1 and 2, bordering adfrontals and turning laterad to include the ocellar area. Adfrontals light brown, their sutures slightly wavy and a little lighter in colour. Frons light brown with brown markings and one dark brown spot in each lower corner. Epicranial index 0.7 to 0.8. Distance from ocelli 1 to 2 from $1\frac{1}{4}$ to 2 times that from ocellus 2 to 3. Postclypeus light brown; preclypeus dirty white. Labrum light brown, broadly notched, at an angle of 100 degrees. Antennal socket pink; basal segment of antenna yellowish; second segment light brown. Prothoracic shield ground colour with brown markings. Anal shield, truncate at posterior end, is ground colour with brown pits scattered over it. Setigerous tubercles of dark brown papillae either set directly on the integument or on large chazae. The posterior setae, i.e., beta, kappa, mu, pi and sigma, are borne on the larger tubercles on any given segment. Spiracles oblong-elliptical in shape, with dark brown rims and light brown centres. Thoracic legs of ground colour with dark markings. Prolegs of ground colour with brown markings; ventral leg with 30 to 36 crochets and anal leg bearing a lateral plate with brown pits scattered over it.

Mouthparts: Mandibles (fig. c) brown, with three ridges and nine teeth, the third and fourth teeth having a sinuate margin. Hypopharynx of the usual type. Spinneret stout, conical, rounded at tip. Labial palpi with segments in the proportion of 10, 3 and 12.

Food Plants: White, red, black, Engelmann, Sitka spruce; tamarack, western larch, balsam, western hemlock, Alpine fir, Douglas fir.

THE DISTRIBUTION AND LIFE HISTORIES OF THE CADDIS FLIES OF WASKESIU LAKE, SASKATCHEWAN

BY D. J. MILNE,

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A study of the caddis flies of Waskesiu Lake was carried out during the summer of 1940 as part of the general program of limnological investigations which have been conducted in Prince Albert National Park, Saskatchewan, since 1928. The importance of caddis flies in the ecology of the lake had been recognized since they provide much food for fish in the near shore region. It was further realized that their ecological relationships could not be determined until the taxonomic position of the local species, especially the immature stages, had been established. The published studies on this group in Western Canada are limited to three papers by Neave (1929, 1933, 1934) dealing with Jasper, Alberta, and Lake Winnipeg, Manitoba. This is the first study of caddis flies in lakes of Saskatchewan.

The work was done under the supervision of Dr. D. S. Rawson of the University of Saskatchewan. Dr. H. H. Ross of the Illinois State Natural History Survey kindly identified representative specimens from the collection*.

DESCRIPTION OF WASKESIU LAKE

This is the second largest lake in Prince Albert National Park, which lies in the Canadian Life Zone, with boreal forests of spruce, poplar, jackpine and white birch. The lake is 27 square miles (70 sq. km.) in area and is 16 miles (26 km.) long. Its maximum depth is 24 metres, with the mean depth 11.1 metres. It is an eutrophic lake and its highest mean temperature, approximately 18.3° C., is reached about August 10. Further data of a physical and chemical nature are provided by Rawson (1935).

METHODS

The larvae and pupae were obtained for qualitative studies by hand collections taken at regular intervals throughout the summer from May 28 to September 3 at fixed stations on the lake shore and in tributary streams. Some of these were used for rearing purposes, both in aquaria and in rearing cages; but for this order the metamorphotypic method described by M. J. Milne (1938) of associating the immature stages with the proper adult by means of collecting mature pupae was found to be superior. The offshore larvae were sampled by an examination of 177 dredging samples taken with an Eckman dredge in Upper Waskesiu during the summer of 1930 by field workers from University of Saskatchewan. About 8,000 adults were obtained throughout the season of 1940 by means of light trap methods and by sweeping. During the following winter, these collections were sorted, identified, and the fauna compared with that of other regions.

COMPOSITION OF THE CADDIS FLY FAUNA

Table I lists the 46 types found at Waskesiu Lake region, 28 of which have been identified to species. This includes 35 adult types, 25 of which have been identified to species and 23 types of larvae and 15 types of pupae, 12 of which have been associated with the corresponding adult. Of the remaining 11 types of immature stages, only 3 were identified to species. This list is necessarily incomplete but it contains the common forms of importance in fisheries work in this region.

The major difficulty in working with North American caddis flies, especially western forms, is one of taxonomy. This is indicated by Ross (1938) in his paper on lectotypes. At present it is difficult to identify the adults to species, *vide* Betten (1934), and it is impossible to go further than genera for many of the immature stages (Milne, 1939). When the proposed revision of

*The specimens are deposited in the Limnological Laboratory, University of Saskatchewan.

TABLE I. Species of Caddis Flies of Waskesiu Lake

Legend	A—Abundant V.A.—Very Abund. X—Present	Lake Waskesiu			Relative abundance	Neave			Marshall
		adults	larva	pupa		1934 Lake Winnipeg	1929 Lakes of Jasper	1939 Lake Erie	
<i>Hesperophylax designatus</i> Wlk.		X			O				
<i>Pychnopsyche guttifer</i> Wlk.		X			R				
<i>Limnephilus bimaculatus</i> Wlk.		X	X	X	O	X			
<i>infernalis</i> Bks.		X			A				
<i>kennicottii</i> Bks.		X			R				
<i>extractus</i> Wlk.		X			R				
<i>canadensis</i> Bks.			X	X	C				
<i>curtis</i> Bks.			X	X	O				
<i>forcipatus</i> Bks.			X	X	O				
sp. A		X	X	X	V.A.				
sp. B		X			O				
spp. No. 1-6			6 X		5 C				
<i>Phryganea cinerea</i> Wlk.		X	X	X	A	A			
<i>Dasystegia improba</i> Hag.		X			O		X		
<i>Agrypnia straminea</i> Hag.		X			O	X			
<i>Ptilostomis</i> sp.		X			R				
<i>Banksiola</i> sp.		X			R				
<i>Mystacides longicornis</i> L.		X	X	X	V.A.			X	
<i>sepulchralis</i> Wlk.		X			C	X		X	R
<i>Leptocella albida</i> Wlk.		X	X	X	A	X			
<i>Athripsodes resurgens</i> Wlk.		X			R	X			C
<i>tarsipunctatus</i> Vorhies		X	X	X	O	X			C
sp.				X	R				
<i>Oecetis albesens</i> Mosely		X			R				
<i>immobilis</i> Hag.		X			R				O
<i>inconspicua</i> Wlk.		X			A				V.A.
<i>avara</i> Bks.		X			R				A
sp.		X			R				
<i>Trianodes</i> sp.		X	X		C				
<i>Helicopsyche borealis</i> Hag.		X	X	X	A	A			A
<i>Brachycentrus</i> sp.		X	X	X	R				
<i>Lepidostoma togatum</i> Hag.		X	X		C				
<i>Hydropsyche recurvata</i> Bks.		X	X	X	C	A			C
sp.		X			R				
<i>Plectrocnemia cinerea</i> Hag.		X			O	X		X	V.A.
<i>Polycentropidae</i>		X			R				
<i>Molanna flavicornis</i> Bks.		X	X	X	V.A.	A		X	
<i>Psychomyiella flavida</i> Hag.		X			R				A
<i>Hydroptila waubesiana</i> Betten		X	X		O				
<i>Ithytrichia</i> sp.		X			R				
<i>Mystrophora</i> sp.			X	X	O				
TOTAL		35	23	15	46	11	5	10	
Number of additional species listed						27	9	37	

this order by Dr. H. H. Ross is published, this difficulty should be largely surmounted.

GEOGRAPHIC DISTRIBUTION OF CADDIS FLIES

The relative abundance of the 46 types collected at Waskesiu Lake is shown in Table I along with the available records reported by two other workers. It should be noted that the reported abundance of each species varies greatly in the different regions. In fact there are only two species common to all four lists. In the list from Waskesiu Lake, 15 species are identified for the first time in Western Canada, and there appears to be at least two new species and many undescribed immature stages. On the basis of the above collections it appears that in general the species are restricted to relatively local areas, with very few cosmopolitan forms. This might be expected in an order where the larvae are aquatic and the adults comparatively poor at flight.

DISTRIBUTION IN WASKESIU LAKE REGION

The general ecological and seasonal distribution of 15 species of adults and 20 types of larvae selected because of their high relative abundance is indicated in Table II. Ten of the larval types have been associated with adults. In examining this table the following points should be considered. The species are grouped in families and show some general tendencies in their habits and choice of habitat, but it is within these family limits that we find the species radiating to locate themselves in every ecological niche at different seasons of the year. This ecological localization and the life history habits will now be briefly summarized.

(1) *Lake Shore Region.* Water less than one metre in depth.

(a) *Rocky Bottom.* Owing to the great molar activity, all the larvae found here make their cases of sand, except *Lepidostoma togatum* which has a neat log-cabin case made of short pieces of vegetable material. This form and *Hydropsyche recurvata* were found in no other habitat. *Helicopsyche borealis* was also found in the rapid portion of streams. Thus this petrophilous fauna constructs cases adapted in shape and material to offer little resistance to and much protection from wave action.

(b) *Sandy Bottom.* The sandy beaches had a very sparse caddis fauna, while the protected sandy bays harboured great beds of *Scirpus* which contained many forms with cases made of sand, especially *Molanna flavicornis* and *Mystacides* spp.

(2) *Offshore Lake Bottom Region.*

The maximum depth at which the plants *Scirpus*, *Chara* and *Potamogeton* were found in Waskesiu was about four metres.

This depth zone contained most of the phytophilous caddis larvae as indicated in Table III. The region of maximum abundance for caddis fly larvae was located at 2.5 metres in depth. Wave action near shore apparently limits their abundance and the lack of plants and the mud bottom restricts their distribution past eight metres. Thus depth is the main factor which indirectly limits their distribution and the nature of the bottom is an important associated factor. In Upper Waskesiu the littoral zone (zero to five metres), although covering only 19.1 per cent of the lake area, produced 90 per cent of the total caddis fauna taken in the dredgings. At variance with the above observations, it is of interest to note that Neave (1933) found in Lake Winnipeg that depth had no effect on the distribution of *Molanna flavicornis* down to 20 meters (the greatest depth in the lake) and that the nature of the bottom (sand) was the limiting factor, due to the conservative case building habits of this larva. In Waskesiu Lake, *Molanna flavicornis* made up 49 per cent of the total bottom caddis fauna, but its depth distribution resembles that for the whole order with maximum density of 29.4 per sq. m. located at two meters. It is apparent that depth is the most important factor at Waskesiu Lake, for at less than five metres there was an average of 1.03 specimens per dredging or 20 per square metre, while deeper than five metres there were no specimens taken in 80 dredge samples, 12 of which were made on sand.

(3) *Larval Distribution in Two Main Streams.*

(a) *Waskesiu River* is the outlet of Waskesiu Lake and flows northward into Montreal Lake. At present the first three-quarter mile portion is dammed. In this stationary body of warm water made up of alternate pools and rocky shallows, the family Limnephilidae with bulky larval cases made of buoyant material was the predominant group. *Limnephilus* sp. A was the characteristic type as indicated in Table II.

(b) *Mud Creek* is a short stream from Mud Lake into Smith's Bay on Lower Waskesiu Lake. There were beaver dams along its course, two of which formed large ponds of stationary water. Besides there were some rocky, rapid flowing riffles. The stony cases of *Limnephilus canadensis* were characteristic of

TABLE III. Distribution of Caddis Fly Larvae in Relation to Nature of Bottom in Waskesiu Lake.

NATURE OF BOTTOM		Depth in metres	Average number per sq. metre	
			All Species	<i>Molanna flavicornis</i>
{	phytal	sand, Scirpus	1-2	91.4
		sand, Chara	1-3	22.5
		sand, Potamogeton	2-4	36.2
	aphytal	sand, gravel	1-3	66.3
		sand	1-11	13.6
		mud	5-11	.9
				57.1
				7.5
				25.4
				29.0
				1.0
				.5

the rocky portions where they were found as dense as 500 per square foot. The larvae of *Limnephilus forcipatus*, *Mystrophora* sp. and *Athripsodes* sp. 1 were also found here. *Brachycentrus* sp. was found in only the fastest riffle in an area of about five square yards. Mud Creek, because of its current, was populated with larval forms with streamlined cases, weighted with stones or anchored with silk, never light and bulky. It is of interest that the last four forms mentioned were not found in the lake. It appears that caddis flies live both by means of (like black flies) and in spite of (like May flies and stone flies) the current strength with a marked variation in degree in different species.

SEASONAL OCCURRENCE OF ADULTS IN LIGHT TRAP MATERIAL

The light trap was located so that a representative sample of the caddis fauna of Lower Waskesiu Lake might be caught. The relative abundance of the forms caught is shown in Table II. Individual night catches varied greatly; on calm, cold, clear, moonlight nights the catch was small, but when the evening was cloudy and warm with a light breeze blowing from the lake, maximum catches of from 500 to 1,300 specimens were obtained. The catch was most abundant just at dusk. About 8,000 caddis flies were collected between July 1 and September 14. From an analysis of this collection, the following species showed one definite brood flight per season. The two species *Mystacides longicornis* and *M. sepulchralis* emerged from July 28 to August 28, with a sharp peak of emergence around mid August. *Athripsodes tarsipunctatus* had a brood flight extending over a longer period, from July 18 to September 3, and *Limnephilus infernalis* had a brood flight in the fall from August 24 to mid September.

In contrast, *Leptocella albida* appeared to have two brood flights per season, July 11 to July 20 and August 24 to September 14. The second, which was larger, may or may not be made up of descendants of the first. There could be either two generations per season or separate brood flights for different localities. Since the larvae were found in June, July and early August at various places, and the adults were collected at Mud Creek in late July and at Waskesiu River mouth in late August, it seems probable that these peaks represent the emergence of broods from different localities with only one generation per season. There is not sufficient evidence to be sure of the case.

Marshall (1939) did not record the above species from Lake Erie, but from light material showed that *Helicopsyche borealis* had two definite brood flights and concluded that it is quite possible, and even probable, that there are two generations in one season. From larval material, it is evident that at Waskesiu Lake, there is only one generation per season for this species.

Lepidostoma togatum appeared to have two distinct brood flights, July 1 to July 20 and August 28 to September 5. The early emergence reached striking proportions as it contributed to about one-half of the total caddis catch. The great majority were females ready for oviposition, as each had a spherical mass of light green eggs hanging from the tip of the abdomen. On July 2 for example, there were 600 females and about 5 males caught. This disparity may be due

to a difference in the phototropic attraction of the sexes to the light, but in this case, it is probably due to an unequal distribution of the sexes in nature (Betten, 1934). On the basis of the larval collections, it seems probable that the fall brood flight is of a closely related species.

The adult of *Molanna flavicornis* was on the wing all season from June to September, with no definite peak of abundance. From a study of the immature stages, it was apparent that there is only one generation per year but that the adults emerged over a long period and must remain on the wing for some time. It is suggested that this might be due to the difference in temperature of the water on the bottom at different depths, but further observations are needed to substantiate such a view.

Oecetis inconspicua has a life history similar to that of *Molanna flavicornis*, with a long adult season, but it has also a definite peak at mid August. No larvae were identified. Marshall (1939) found two brood flights on July 1 and August 15 for this very abundant species in Lake Erie, but it is difficult to believe that this is due to two generations per season.

It appears doubtful if any form found at Waskesiu has more than one generation a year, although two generations are known to occur in Southern Europe, and Mrs. Davis (Betten, 1934) found that in New York State the larval stage may last only twenty days in the summer. Marshall (1939) recorded two brood flights for four species at Lake Erie and is of the opinion that they have two generations per season. Three of these species occur at Waskesiu Lake. At Waskesiu Lake all forms studied in detail have apparently only one generation per year but some species emerge in a sharp peak and have a short adult life, while others emerge over a longer period without such a pronounced peak and probably have a longer adult life. The time of emergence was found to vary in the different species, and in some it appears to vary in the different localities. In addition there was no evidence that any species might have a two-year cycle.

LIFE HISTORY CONTRIBUTIONS

The seasonal occurrence of the adult and the immature stages for the summer months is summarized in Table II. The studies of the following nine species were supplemented by observations made from aquaria and field cages.

Limnephilus bimaculatus Wlk. In June, the larvae of this form were abundant in the creeks and protected bays wherever there were dead twigs. They were not found after July 15. Of three pupae collected in Waskesiu River on June 28, two left their cases on July 6 but failed to emerge from the water. A twig was then placed in the jar and on July 13 the third pupa emerged successfully, leaving its pupal exuvium attached to the twig one inch above the surface of the water. This form appears unable to escape freely from the surface of the water. From several larvae collected in the lake on July 5, one adult emerged on July 20 from a cage kept in the cooler lake water. Adult specimens were on the wing from July 2 until the end of August.

Limnephilus sp. A. These larvae with their cumbersome log-cabin cases were characteristic of standing pools in the Waskesiu River, being found there on all types of bottom. Their cases were made of short, green *Chara* fragments, longer dead *Chara*, plus a conglomeration of molluscan shells and sand or of *Potamogeton* leaves with large balls of *Nostoc*. They were made apparently of whatever was at hand, and if the available material changed as they moved over the bottom, so did the composition of their cases. Attempts to rear them were unsuccessful, as the pupae were not easily located and the larvae failed to pupate in captivity. The adults were on the wing in late August and September.

Phryganea cinerea Wlk. A few larvae were found up to July 15 in the

dredgings and on plants. A pupa from the lake placed in an aquarium on July 22 emerged as an adult on August 28 from the surface of the water. This agrees with Neave (1933) who observed adults emerging from the water in Lake Winnipeg several miles from land. In Waskesiu Harbour the larva pupated by rolling up in a leaf on the *Potamogeton* plants. Specimens of these pupae died in aquaria, but the adults were obtained in the nearby light trap, and exuvia were found on the surface of the water from July 15 to 30. The adults were on the wing from July 15 to August 15. From July 20 to July 31, rings of pale green eggs were found attached to the reeds along the shore. These rings were 30 millimeters in diameter and 5 millimeters in thickness. In one case the adult had apparently climbed down a *Potamogeton* stem to attach its string of eggs 18 inches below the surface of the water. There was some indication that the eggs were laid during the night. At the mouth of the Waskesiu River eggs hatched on July 27. In aquaria they hatched on August 1, and a series of larvae were retained until August 26 when they had reached 8 millimeters in length.

Mystacides longicornis L. The larvae, with their sandy cases, were abundant in June and July in the *Scirpus* beds of sandy bays. Pupae were collected from Waskesiu River on June 28 and placed in aquaria from which two adults emerged on July 6 and one on July 13. Adults were found in the light trap from July 30 to August 28 in the Lower Lake. In the Upper Lake many adults had emerged on July 13 and were caught when attracted by a gasoline lantern in greater numbers in mid-lake than along the shore. The young larvae were found in September under the rocks along the shore.

Athripsodes tarsipunctatus Vorhies. The occurrence of these larvae was similar to that of *Mystacides* sp. Pupal specimens were collected from Waskesiu River on June 28, and two adults emerged from the aquaria on July 4 and 6. Pupae were found in the river until the first of August. Adults were caught in the light trap from July 18 to September 3.

Helicopsyche borealis Hag. The little, coiled, snail-like cases of these larvae were found in both lakes and streams wherever there was sand and rock. They are abundant until the end of June when all pupated in a gregarious fashion on the side of rocks in one foot of water. One adult emerged on July 4 from pupae collected from rocks on the lake shore on June 28. By July 8 most of the pupae on the rocks were found dead for no apparent reason. Adult specimens were on the wing during all of July, and by August 19 young larvae were again occupying the rocks. For this widespread species there is apparently only one generation per season and one brood flight (Marshall, 1939).

Brachycentrus sp. These larvae were found only in the swiftest riffles of Mud Creek from May until August. A field cage was set in Mud Creek and larvae were put into it on June 29. Two adults emerged on August 17 and 25. From the larvae that were placed in aquaria on July 22, one adult emerged on August 26. It emerged from the surface of the water, leaving its case attached to a plant stem one inch below the surface. Thus it is adapted to emerge from rapid water but can live in an aquarium. On September 3, when the aquaria were emptied, one larva had not yet pupated.

Hydropsyche recurvata Bks. These carnivorous larvae have no portable cases but build larval corrals of small stones. They were found on the underside of rocks at the shoreline, and they catch their food by means of silk nets. These larvae pupated in early July by crawling between rocks. The two surfaces touching the rocks were a membranous cocoon. The other surfaces were covered with small stones attached to the cocoon by means of silk. From pupae collected July 9, one adult emerged on July 20 from a cage in Waskesiu Harbour. During most of August, there were full grown larvae, pupae, and young larvae of all sizes on the same stones, with adults flying along the shore. Thus, for some reason, these specimens were growing at vastly different rates.

Molanna flavicornis. Bks. These specimens were found in the littoral region of the lake wherever sand and plants were found together. Three pupae were collected at the mouth of Waskesiu River on June 28 and put in an aquarium. The adults emerged on July 4, 6 and 9. They emerged from the surface of the water without any aid during the night. In the lake, adults emerged from the pupae located two to four metres in depth, with those close to shore emerging earlier in the season. This is probably due to the temperature, as adults were found at the mouth of Waskesiu River on June 1, yet on August 11 two pupae were located at 4 metres in the lake. The period of adult life extends from July 1 to September 15.

SUMMARY

During the summer of 1940, forty-six types of caddis flies were collected from Waskesiu Lake region, twenty-eight of which were identified to species. Fifteen species are recorded for the first time from Western Canada, and some undescribed larval and pupal stages were collected.

The geographic distribution and relative abundance of the caddis fly fauna is compared with the published lists of Neave (1929), Neave (1934) and Marshall (1939), whose collections were made at Jasper Park, Lake Winnipeg and Lake Erie respectively. Limited distribution of species was noted with only two species reported in all four localities.

The ecological and seasonal distribution of twenty-five types is given for Waskesiu Lake. From an analysis of dredging samples, it was concluded that the distribution of the larvae in the lake was restricted by the action of the waves and the depth of the water. These two primary factors affect the nature of the bottom which is important in connection with the food, oxygen and case building requirements of the larvae.

In streams the larvae were found to be restricted chiefly by the strength of the current. The size, form and material of the larval case is apparently important in permitting successful occupation of any habitat.

The nine species studied from light trap collections all have one generation per year, but there was much variation in the time and duration of the adult flights.

Life history data is given for a number of species.

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